

UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY

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INTERFAITH COMMUNITY  
ORGANIZATION, *et al.*,

Plaintiffs,

v.

HONEYWELL INTERNATIONAL,  
INC., *et al.*

Defendants.

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) CIVIL NO. 95-2907 (DMC)  
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**DECLARATION OF BRUCE M. SASS**

I, Bruce M. Sass, under penalty of perjury, declare as follows:

**QUALIFICATIONS**

1. I have extensive experience and education in the fields of geochemistry, mineralogy and environmental science and I am a Senior Research Scientist with Battelle Memorial Institute ("Battelle") located at 505 King Avenue, Columbus, Ohio 43201.

2. I hold a Bachelor of Science degree in Geology from the State University of New York, a Master of Science degree in Geochemistry from Washington State University, and a Ph.D. in Physical Chemistry from the University of Pennsylvania.

3. I have worked in the fields of mineralogy, geochemistry and environmental science for over 17 years and have held a senior scientist position at Battelle since 1991. Battelle is a not-for-profit global technology enterprise that develops technology and manages a vast

network of prestigious national laboratories. Headquartered in Columbus, Ohio, Battelle has an immense science and technology reach and its laboratories oversee 19,000 professional and staff members and conduct \$2.9 billion in annual research and development.

4. I am a member of the American Chemical Society, the Geochemical Society of America and the American Institute of Chemical Engineers. I am also the lead inventor on a patent concerning the separation of carbon dioxide from gas mixtures.

5. I have authored or co-authored over 50 scientific publications and presentations including four peer reviewed papers on the behavior of chromium and one technical proceedings paper on expansion of chromite ore processing waste ("COPR").

6. I have extensive experience in geochemistry and mineralogy of COPR. I performed extensive work in the mineral characterization of COPR using state of the art spectroscopic techniques including scanning electron microscopy ("SEM"), electron probe microanalysis ("EPMA") and x-ray diffraction ("XRD") with quantitative whole pattern fitting techniques. I investigated the mechanism of COPR lithification and expansion utilizing thermodynamics, kinetics and other scientific principles, and I developed specialized modeling techniques for estimating expansion and mineral composition of hydrating COPR. I have also analyzed geochemical data from the Site<sup>1</sup> and determined critical steps in Mutual Chemical Company's ("Mutual") dichromate production processes, as well as external inputs that are responsible for the chemistry and mineralogy of present day COPR and its heave potential.

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<sup>1</sup> The Site consists of 34 acres of real property located between Route 440 and the Hackensack River in the City of Jersey City. Approximately 33 of the 34 acres are owned by Honeywell (the "Honeywell Property"). The balance of the Site, consisting of approximately one acre at the northeast corner, is owned by Roned Realty of Jersey City, Inc. (the "Roned Property").

7. I also have substantial experience in the environmental fate of chromium in the context of environmental remediation. I have been a Project Manager for the U.S. Environmental Protection Agency relating the chemical reduction of hexavalent chromium in laboratory studies, I developed a geochemical model that predicted the fate of chromium in groundwater following site remediation at the former Long Beach Naval Shipyard, and I designed an analysis plan for the evaluation of the mechanism for chelation of chromium in the remediation of a wood pulping facility.

8. A copy of my current curriculum vitae that includes a list of the publications that I have authored/co-authored over the last ten (10) years is annexed here as Exhibit A.

9. I have not given expert testimony either at trial or by deposition during the last four (4) years.

#### **FAMILIARITY WITH COPR AT THE SITE**

10. I first became involved with issues concerning the expansion of COPR when I was retained as a subcontractor to Honeywell International Inc.'s ("Honeywell") consultant, Parsons Engineering, Inc. ("Parsons") in November 1999. At that time, I was assisting Parsons in its work for Honeywell at the Dundalk Marine Terminal ("DMT"), in Baltimore, Maryland. My work was focused principally on supporting Parsons in identifying a geotechnical solution to the heaving at DMT.

11. My initial work centered on developing an understanding of the chemical mechanism or mechanisms responsible for heaving caused by COPR. I visited DMT in November 1999 and observed trenching in a heaved area and also observed heaved ridges, cracked pavement, and duct banks where electrical and other wiring had been damaged by heaving. I reviewed reports documenting Mutual's dichromate production in Baltimore and

reports on heave analysis at DMT by the University of Maryland and by Fluor Daniel-GTI (“Fluor”), which were the most comprehensive sources of information about COPR at that time. Both reports indicated that COPR contained unreacted brownmillerite and its hydration products (chiefly aluminoferrite-mono phases), and calcium hydroxide, as well as periclase and its hydration product magnesium hydroxide (brucite). In addition, calcium carbonate and more complex carbonated compounds also were reported. Due to my training in mineralogy and familiarity with the cement chemistry, I recognized this suite of minerals to be a subset of minerals found in hydraulic cements. With that understanding, I proceeded to perform analyses using XRD to confirm the mineralogy reported by the University of Maryland and Fluor, and SEM to identify specific COPR minerals and to provide a base level characterization of their size, distribution, and spatial relationship to other compounds. I was also provided with approximately 10 COPR samples from DMT and another 10 samples from the Site with which to conduct my studies. Results of these early studies showed that the chemical analyses and XRD patterns of COPR at both sites were essentially identical.

12. My work for Parsons concluded in approximately June 2002. At that time, I was unable to pinpoint a mechanism for COPR expansion or lithification which would potentially lead to heaving, other than to conclude generally that two hydraulic (cement) components were present in the COPR (brownmillerite and periclase) and that these components were potentially important to the geochemical mechanism of COPR heave. I understood that about 50% of the “black sand” (which we now refer to as B-horizon COPR) was composed of brownmillerite and less than 5% was periclase. I hypothesized at the time that depending on the availability of moisture, the hydraulic components in the black sand would hydrate. Furthermore, I hypothesized that sometime in the future the sand grains would dissolve leaving hollow grains;

hydration products of brownmillerite and periclase would precipitate in the space formed by the hollow grains (Hadley grains) as well as in the void space between the grains and that this could lead to expansion of the "black sand."

13. During my work for Parsons, I also was involved with a study involving mortar bar tests that were conducted at Construction Technology Laboratory (CTL) under the direction of Mr. Vagn Johansen. Although mortar bar tests are standard in the cement industry to determine the expansion rate of cement and concrete, the CTL testing did not employ standard ASTM methods of analysis. Preliminary results of these tests showed that mortar bars composed of crushed COPR from both the Site and DMT expanded at a rate of up to 1% per year at an elevated temperature of 38°C, and at much slower rates (approximately 5 times slower) at room temperature (23°C). I compared expansion rates from the mortar bar with a semiquantitative chemical analysis that Battelle had available and preliminarily concluded that the expansion rates were correlated with magnesium content.<sup>2</sup>

14. At that time my work for Parsons concluded, I had only progressed to a point where I could hypothesize that COPR expansion (that ultimately manifested in surface heave) was either driven by the hydration reaction of brownmillerite or periclase. Based on semiquantitative chemical analyses performed on the mortar bars (which analyses were understood to be inadequate at the time), I considered the periclase-to-brucite reaction as a main cause for expansion of COPR, but also believed that brownmillerite was an important driver,

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<sup>2</sup> In August 2003, I reviewed the results of a new quantitative analysis of the COPR used in preparing the mortar bars and concluded from this later analysis that no correlation existed between expansion rate and magnesium.

because it was present in large abundance in the COPR and formed a complex assortment of hydration products.

15. After concluding my work for Parsons relating to DMT in June 2002, I had no further connection with the COPR investigation for over one year. Then, in or about June 2003, I was asked by Honeywell, through Parsons, if I would serve with other outside scientists and engineers on a team whose mission included resolution of the mechanism of COPR heaving and finding a permanent solution to surface heaving at the Site. In June 2004, Honeywell contracted for Battelle's services and my assignment as part of the team focused on gaining a complete understanding as to the geochemical mechanism of COPR heave and expansion.

16. In executing Battelle's assignment, I have taken field observations at the Site and at DMT, conducted literature searches and reviews, undertook a historical review of the chemical processes at Mutual's Jersey City and Baltimore plants that produced COPR, performed detailed mineral characterization on numerous COPR samples from the Site and DMT using state-of-the-art imaging and spectroscopic techniques, designed and performed modeling of chemical reactions taking place within the COPR, reviewed vast amounts of data from the Site and from the DMT, and collaborated with Battelle scientists and other scientists working on the COPR project including Dr. Daniel Kremser and Dr. Bruce Buxton, both of Battelle, Dr. Rudy Bonaparte of GeoSyntec Consultants, Dr. James K. Mitchell, University Distinguished Professor, Emeritus at Virginia Polytechnic Institute and State University in Blacksburg, Virginia, and Dr. Dimitris Dermatas of Stevens Institute of Technology.

#### **EXPERT OPINIONS**

17. In connection with Honeywell's application to this Court pursuant to Rule 60 (b), I was asked to provide my professional opinions with respect to a number of issues relating to the

geochemical basis of COPR heave. My professional opinions and the bases thereof are set forth in the following paragraphs.

18. Opinion on the Mineralogy of COPR and Basis Thereof

My professional opinion is that the mineralogy of COPR is as follows:

- COPR's mineralogy principally consists of three classes of parent compounds (*i.e.*, those formed in the high temperature kiln environment which was part of the Mutual production process). Of the three, brownmillerite is the most important. Brownmillerite is a ferrite compound having the ideal formula  $C_4AF$ , which in cement nomenclature indicates it is composed of four CaO groups, one  $Al_2O_3$  group, and 1  $Fe_2O_3$  group. In the COPR at the Site, as well as in the COPR at DMT, brownmillerite is found to have excess iron and substitution of trivalent chromium for aluminum and iron.
- The other parent compounds of COPR are periclase (magnesium oxide) and chromite, which occurs as small relic grains at the center of some nodules. (At a microscopic scale COPR "grains" consist of small, generally 0.2 to 0.5 mm diameter nodules that are remnants of chromite ore that was finely ground and processed as a fluidized material inside the kiln). The presence of chromite inside the nodules indicates that the kiln process was less than 100% efficient in extracting chromium from the ore and converting it to a form that could be recovered by leaching (*i.e.*, sodium chromate).
- All other compounds that are found in COPR, except soil minerals that most likely were inadvertently admixed at the Site, are hydration products of periclase and brownmillerite. In order for some of these hydration products to form, certain additional chemical species are needed, in addition to water. These additional



chemical species were impurities in the ore, additions from the production process (most notably lime), or were available in the Site environment.

- Brucite is a direct product of periclase hydration. Similarly, portlandite is a product of lime hydration, but, due to rapid reaction kinetics, it was formed while the processed ore was being leached with water. Associated with portlandite is the calcium carbonate mineral calcite, which was formed due to carbon dioxide absorbing from the atmosphere into lime-rich water after the COPR was slurried onto the Site. Another simple hydration product is ferric hydroxide, the main product produced from the ferric iron that was liberated from brownmillerite. Although not detected by XRD because it is amorphous, my opinion is that chromic hydroxide  $[\text{Cr}(\text{OH})_3]$  is a product of trivalent chromium that is released as brownmillerite becomes hydrated.
- Hydrogarnets are another important class of products that can form either as a direct result of brownmillerite hydration, or following the formation of intermediate aluminoferrite-mono compounds, which are described below. Samples from the Site and DMT include katoite and hydroandradite.
- Hydrotalcites, another hydration product of brownmillerite, are a group of magnesium aluminum carbonate hydrates and include minerals such as hydrotalcite, stichtite, quintinite, sjögrenite.
- COPR contains small amounts of calcium silicate hydrates (known as C-S-H) and occasionally a crystalline form known as afwillite. My opinion is that in this silicate group silica was provided to the system through the chromite ore and gangue minerals associated with the ore.



- Perhaps the most important class of hydration products is the aluminoferrite-mono compounds (“AFm”), which tend to form crystalline solids with hexagonal symmetry. The AFm compounds, which are among the first crystalline platelets to form upon hydration of brownmillerite, have the ability to combine with several types of anions, such as chromates, sulfates, and carbonates to produce a cementing matrix that results in a lithified material. Examples of AFm reaction phases include: calcium aluminum monochromate hydrate; calcium aluminum monosulfate hydrate (including the related mineral kuzelite); and calcium aluminum carbonate hydrate. These three types of compounds could not exist in COPR were it not for limited amounts of chromate, sulfate, and carbonate, respectively, being present. Residual chromate ( $\text{CrO}_4^{-2}$ ) was present due to incomplete leaching following conversion of trivalent chromium in the kiln. Historically, the stockpiling of COPR resulted in dewatering and eventually drying by evaporation. My opinion is that the drying process concentrated the chromate and caused it to combine with other components present in the COPR, such as – but not limited to – calcium, aluminum and iron, and led to the formation of intermediate chromate compounds with low solubility. This process allowed chromate to become precipitated in a solid phase within the COPR, while making it possible for mobilization and re-precipitation at a later time. With regard to sulfate availability, my opinion is that limited sulfate entered the system at the time of COPR deposition at the Site due to use of estuarine river water in the slurring operation. Carbonate entered the system due to absorption of carbon dioxide from the air as ponds containing high pH brine lay over the COPR after it was slurried onto the Site in the early days of the fill operation.

- Another mineral found in overall low abundance in the COPR at the Site is ettringite. Ettringite is classified as an aluminoferrite-tri compound (“AFt”) that was formed during or soon after deposition due to its rapid precipitation kinetics. However, ettringite formation would have ceased as soon as the limited availability of sulfate from the river water had been consumed. Additionally, some ettringite would have converted to Afm monosulfates that are more stable as alumina levels increase.
- On occasion, but especially in the A-horizon quartz, feldspar, and clay minerals also have been found in low abundance.

Exhibit B which is annexed hereto illustrates the mineralogy of COPR at the Site.

19. In connection with formulating my professional opinion as to the mineralogy of the COPR at the Site, I performed the following activities:

- The activities described in Paragraphs 6, 11 and 16 above.
- Verified the stability of the identified minerals in aqueous environments using equilibrium thermodynamic calculations.

20. Opinion On Separate COPR Layers (“Horizons”) At Site

My professional opinion is that the COPR material at the Site is divided into three distinct layers (or “horizons”) that are geophysically and geochemically distinct: the A, B and C horizons.

21. Basis for Opinion

Based upon my work relating to the Site, including but not limited to my field observations and my analysis of samples from the Site, the uppermost horizon, the A horizon, which occurs in the top 1 to 3 ft., is comprised of COPR and non-COPR materials such as asphalt and gravel. The B horizon comprises the intermediate zone and in general, occurs in the first 10 feet below the A horizon. The B horizon consists of coarse granular, gray-black COPR. The

mineralogy of the B horizon COPR is predominantly brownmillerite, periclase and hydration products such as those mentioned in the paragraphs above. The B horizon consists of both non-lithified and lithified COPR. As set forth below at paragraph 24 lithified COPR is a material made from B horizon COPR that has formed an inter-granular cement that changes the loose granular material into a gradation of hardened COPR that can result in a hard rock-like unit. In general, the C horizon is the deepest zone of COPR. The C horizon is below the B horizon and extends to the meadow mat. The C horizon COPR consists of fine grain, gray-white material with a clayey texture. The mineralogy of the C horizon is predominantly calcite and hydrated lime with small amounts of brownmillerite and its hydration products. The C horizon is non-lithified COPR. Exhibit C annexed hereto illustrates the A, B and C horizons at the Site. Exhibits D and E are photographic images of non-lithified B and C horizon COPR, respectively.

22. In connection with formulating my professional opinion as to the existence and composition of three distinct geophysical and geochemical vertical layers (horizons) at the Site, I performed the following activities:

- conducted detailed mineral characterization on over 70 COPR samples from the Site and from DMT using state-of-the-art imaging and spectroscopic techniques,
- field observations,
- observations of samples collected in the field,
- examined data from test pits dug at the Site and DMT,
- studied cone penetrometer test ("CPT") data at the Site and DMT.

23. Opinion on Geochemical Mechanism of COPR Lithification and Expansion

My professional opinion is that the geochemical mechanism of COPR lithification and expansion (which are the underlying cause of surface heave as explained in the Declaration of Dr.

Rudolph Bonaparte) is now understood. COPR expansion requires the existence of lithified COPR and the hydration of primary compounds contained in the lithified COPR.

24. Basis for Opinion

COPR Lithification

- Lithification is the geochemical process by which mineral grains become cemented together in a three-dimensional matrix resulting in a hard and rock-like material. Lithification involves the creation of cementing bonds throughout the COPR matrix, where the cement can be thought of as a bridgework structure consisting of crystalline solids that lock the COPR nodules together so that they cannot slip or roll under a stress. By analyzing CPT data and separately examining samples collected from the field through microscopic imaging, it is clear that there are many degrees of cementing in COPR at the Site. Mineralogically, these cements may consist of calcite, hydrotalcite, C-S-H, and monochromate phases. Exhibit F consists of photographic images of lithified COPR.
- The majority of COPR observed at the Site is from the B horizon and is characterized as being gray-black in color. The B horizon COPR includes COPR that is both above and below the water table. Some of this material exhibits stiffness, but is not considered to be lithified because the cementing matrix is not very extensive and therefore the material is not strong. For example, one can easily crush this material by hand, whereupon the weakly cemented grains disaggregate and form a loose sand. Examination of these weakly cemented materials by microscope in bulk and in polished sections shows that the cementing matrix occupies only a fraction of the void space (i.e., the space between mineral grains). In contrast, samples of hard COPR

layers collected from test trenches at the Site are quite different in appearance. These lithified materials are much stronger and have color that ranges from yellow to red to brown. Mineralogically, these lithified materials are characterized by larger amounts of “monochromates” and “monocarbonates” and by lower amounts of brownmillerite.

- COPR lithification occurs as follows:
  - As explained in Paragraph 18, intermediate chromate compounds with low solubility were stored in the COPR due to stockpiling and drying. After this COPR was deposited at the Site, a water table was created 7 to 9 feet below ground surface, allowing water to contact it continuously in the saturated zone (at the water table and below) and intermittently in the unsaturated zone (above the water table). The periodic influx of water from the surface passing through the unsaturated zone solubilized the intermediate chromate compounds over time and mobilized hexavalent chromium downward toward the water table. This mobilization of hexavalent chromium took place until most of it had migrated from the vadose zone to the water table, where it collected as a concentrated layer. As this process transpired over a period of years, brownmillerite began to react with water (the hydration process) forming AFm compounds and hydrogarnet. The aluminum component of these hydrated phases (AFm and related precursor minerals) is more reactive than aluminum in the parent brownmillerite. Therefore, chromate anions produced by the leaching chromate could more easily react with the hydrated alumina compounds forming calcium aluminum monochromate hydrates (“monochromates”). Formation of monochromates is especially prevalent where hexavalent chromium was concentrated near the water

table. In addition, the lower abundance of brownmillerite in the chromate-rich zone confirms that chromate was responsible for promoting the hydration of brownmillerite, by its reaction with the alumina compounds. This process released more reactive alumina to form more monochromates. The process is analogous to how sulfate (as gypsum) promotes and accelerates conversion of brownmillerite to ettringite, in the hydration of oil field cements.<sup>3</sup>

- The combined effects of hexavalent chromium leaching downward from the vadose zone and the availability of AFm reaction phases due to brownmillerite hydration created conditions that were optimal for forming large amounts of monochromates near the water table, and in doing so, caused a high degree of cementing to occur between the COPR grains at that location, resulting in the formation of lithified COPR.
- Mobilization of hexavalent chromium as described above is confirmed by bulk chemical analysis of B horizon COPR that shows that concentrations below the water table are comparable to that of the original COPR (~0.5% as Cr), depleted above the water table (0.1-0.2% as Cr) and enriched in the lithified COPR layer near the water table (>5% as Cr). XRD analysis shows that there are no intermediate chromate bearing compounds left in the lithified COPR, indicating that all the available hexavalent chromium has been consumed in making monochromate cement.

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<sup>3</sup> Oil field cements are used to rapidly form a seal between oil well casings and the geological formations around them.

### COPR Expansion

- The mechanism of COPR expansion is driven by the hydration of the brownmillerite contained in the lithified COPR. Brownmillerite provides the “engine” for lithified COPR expansion. Brownmillerite is thermodynamically unstable in water. It converts to stable hydration compounds in the presence of water in a liquid form. In the absence of impurities and external environmental inputs, the hydration products from the hydration of brownmillerite at the Site are hydrogarnets, AFm phases, ferric hydroxide, chromic hydroxide, and portlandite. Each of these has lower density than brownmillerite, and therefore, occupies more space than the parent brownmillerite when compared on an equivalent molar basis. Other brownmillerite hydration products at the Site are monochromates, calcium aluminum carbonate hydrates, calcium silicate, hydrates, hydrotalcites, ettringite, and a solid solution of ferric and chromic hydroxides. These minerals are found both inside the COPR nodules, where they tend to increase the size of the nodules, and outside the nodules, where they exert forces between the grains and the intergranular cement that enhances the material’s rigidity. Continued hydration results in nodules bulking, *i.e.* becoming larger and less dense, as the reactions proceed. As the nodules bulk in all directions, stresses are produced within the lithified COPR rigid matrix causing the lithified COPR to expand. Exhibit G annexed hereto illustrates lithified COPR expansion due to the hydration of brownmillerite. The Declaration of Dr. Rudolph Bonaparte explains how expansion caused by mineral grain volume increases (bulking) in the lithified COPR causes surface heave.



25. In connection with formulating my professional opinion as to the geochemical mechanism of COPR lithification and expansion, I performed the following activities:

- Reviewed the scientific literature on the geochemistry and mineralogy of chromium waste residues.
- Investigated the mineralogy and geochemistry of AFm compounds, especially the work of Prof. Herbert Pöllmann and his colleagues in Germany, who have published extensively on the mineral structure of monochromate compounds.
- Reviewed the investigations relating to COPR heave at the Site and at DMT that were conducted by various consultants and institutions including Parsons, Mueser Rutledge Consulting Engineers (“MRCE”), the University of Maryland, and Fluor.
- Conducted detailed mineral characterization on over 40 COPR samples from the Site and from DMT using state-of-the-art imaging and spectroscopic techniques.
- Made field observations.
- Examined data from test pits and trenches dug at the Site and at DMT at the direction of MRCE and by GeoSyntec Consultants at the Site and DMT.
- Studied cone penetrometer (“CPT”) data collected by MRCE at the Site and at DMT.
- Designed and performed geochemical modeling to confirm equilibrium stability of observed phases.
- Collaborated with other scientists including Dr. Daniel Kremser of Battelle, Dr. Rudy Bonaparte, and communicated with Prof. H. Pöllmann at Martin-Luther-University.

26. Opinion on the Percent of Brownmillerite Already Reacted

My professional opinion is that approximately 50 percent of the brownmillerite in the B horizon has already reacted.

27. Basis For Opinion

My professional opinion as to the percentage of brownmillerite that has already reacted is based upon modeling as to the historical amount of brownmillerite produced in the high temperature kiln process, XRD observations of brownmillerite on 70 samples of COPR from both the Site and DMT, calculations performed by me, and geochemical modeling that confirms my calculations as to the amount of brownmillerite that has reacted.

28. Opinion on Absence of Expansion in Non-Lithified COPR

My professional opinion is that non-lithified COPR in the B horizon and C horizon at the Site will not expand.

29. Basis for Opinion

B Horizon COPR

- Non-lithified COPR in the B horizon does not expand because (1) there is ample void space in the B horizon COPR to absorb the mineral grain volume increase (bulking) caused by hydration, and (2) the products of hydration in the non-lithified B horizon COPR are not forming within the constraints of a rigid, cemented matrix, such as exists in lithified COPR.
- Non-lithified COPR in the B horizon undergoes mineral grain bulking when hydration of brownmillerite and periclase occurs. Non-lithified COPR has been measured to have a void space of up to 40%. The calculated change in mineral grain volume due to the hydration of all remaining brownmillerite in the B horizon COPR is approximately 9%. The brownmillerite and periclase in the B horizon COPR is approximately 50% reacted (hydrated). It has taken between 50 and 100 years for the first 50% of the reaction to occur. There is ample void space (up to 40%) to absorb

the mineral bulking in the non-lithified B horizon COPR (9%) that will occur over the next 50 to 100 years as the balance of the brownmillerite and periclase react.

#### C Horizon

- C horizon COPR is dominated by small silt - and clay-sized particles loosely arranged without any rigid, cemented matrix. In addition, the non-lithified C horizon COPR has a substantial amount of void space. As a result, any mineral grain bulking can more than be accommodated in the C horizon void space. The C horizon COPR, on average, also has a much lower concentration of brownmillerite and periclase than exists in the B horizon COPR. This means that the C horizon COPR has less potential to experience bulking than B horizon COPR. As a result, the volume increase in the C horizon COPR caused by mineral grain bulking will be less than the 9% that will occur in the B horizon COPR. Any mineral volume increase due to hydration occurring in the C horizon can be accommodated in the void space. This ability to accommodate the bulking and absence of any rigid, cemented matrix confirms that the C horizon COPR will not expand.

30. In connection with formulating my professional opinion on the inability of non-lithified COPR in the B horizon and C horizon to expand, I performed the following activities:

- Conducted detailed mineral characterization on over 70 COPR samples from the Site and from DMT using state-of-the-art imaging and spectroscopic techniques,
- Evaluated COPR water content data from the Site obtained by MRCE and HydroQual, Inc.,
- Performed calculations as to volume expansion of non-lithified COPR at the Site using assumptions that hydration of brownmillerite occurs according to a

stoichiometric mass action equation that results in thermodynamically stable products, that water required to produce hydration products is available, that the amount of brownmillerite in the B horizon COPR is thirty (30) percent by weight which is consistent with field samples, that the bulk density of the B horizon COPR is  $1.5\text{g/cm}^3$ , which is based upon a Battelle model and is consistent with field measurements, and that water-filled porosity is as high as forty (40) percent which is consistent with field measurements, and

- Studied CPT data collected by MRCE at the Site.

31. Opinion On No Further COPR Lithification If EMME Remedy Is Implemented

My professional opinion is that lithification will not occur in the COPR that will remain at the Site in the event the proposed Excavation and Multimedia Encasement (“EMME”) Remedy is implemented.

32. Basis For Opinion

My professional opinion is based upon the geochemistry of the COPR at the Site, the mechanisms associated with lithification and expansion of COPR as set forth above, and an understanding of the proposed EMME Remedy described in the Declaration of Dr. Kirk W. Brown. As described by Dr. Brown, the EMME Remedy will result in a closed system beneath the geomembrane so that there will not be any chemically significant infiltration of carbonates, chromates or sulfates nor will there be external inputs capable of materially altering the pH level of the groundwater below the geomembrane. As such, no future lithification will occur in the remaining COPR after the EMME Remedy is implemented.

33. My professional opinions set forth throughout this Declaration are all within a reasonable degree of scientific certainty.

I certify under penalty of perjury that the foregoing is true and correct. Executed this

6 day of October 2005.

  
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BRUCE M. SASS

**UNITED STATES DISTRICT COURT  
DISTRICT OF NEW JERSEY**

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INTERFAITH COMMUNITY	:	
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ORGANIZATION, et al.,	:	
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Plaintiffs,	:	
	:	
-vs-	:	
	:	
HONEYWELL INTERNATIONAL INC.,	:	
	:	
et al.,	:	
Defendants.		

**CERTIFICATION OF FACSIMILE SIGNATURE**

JOHN M. AGNELLO, of full age, does hereby certify as follows:


1. I am an attorney at law of the State of New Jersey and a member of the firm of Carella, Byrne, Bain, Gilfillan, Cecchi, Stewart & Olstein, co-counsel for defendant Honeywell International Inc. ("Honeywell").

2. In connection with Honeywell's motion to modify the full excavation element of the Final Judgment, the Declaration of Bruce M. Sass has been filed with the Court. The Declaration bears a facsimile signature.

3. Dr. Sass has acknowledged to me the genuineness of his signature appearing on his declaration.

4. A copy of the Declaration with an original signature affixed will be filed if requested by the Court or a party.

I certify under penalty of perjury that the foregoing is true and correct. Executed on October 6, 2005.



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JOHN M. AGNELLO [JMA 0338]